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Growth rate and survival of hard coral *Acropora* sp. in turbid waters of the Spermonde Islands, South Sulawesi, Indonesia

DEDI PARENDEN[1,♥], CHAIR RANI[2], JAMALUDDIN JOMPA[2], WILLEM RENEMA[3], JEREMIAS RUMALA TUHUMENA[4]

[1]Department of Fisheries, Faculty of Fisheries and Marine Science, Universitas Papua. Jl. Gunung Salju Amban, Manokwari 98314, West Papua, Indonesia. Tel./fax.: +62-986-211430, ♥email: d.parenden@unipa.ac.id
[2]Department of Marine Science, Faculty of Marine Science and Fisheries, Universitas Hasanuddin. Jl. Perintis Kemerdekaan KM. 10, Makassar 90245, South Sulawesi, Indonesia
[3]Naturalis Biodiversity Center. Darwinweg 2, 2333 CR Leiden, Netherlands
[4]Department of Aquatic Resources Management, Faculty of Agriculture, Universitas Musamus. Jl. Kamizaun, Merauke 99600, South Papua, Indonesia

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Abstract. *Parenden D, Rani C, Jompa J, Renema W, Tuhumena JR. 2024. Growth rate and survival of hard coral* Acropora *sp. in turbid waters of the Spermonde Islands, South Sulawesi, Indonesia. Biodiversitas 25: 3208-3216.* Coral reef recovery is often done by utilizing coral reproduction or coral transplantation. The aim of this study was to observe the rate of coral growth, coral survival in turbid waters, and its relationship to environmental parameters. The method used is spider webs with coral fragments. The results of hard coral restoration research of the genus *Acropora* in turbid waters using web spider transplantation media showed that the growth rate of *Acropora donei* Veron & Wallace, 1984 and *Acropora millepora* (Ehrenberg, 1834) in length was faster than in width. In contrast, *Acropora muricate* Linnaeus, 1758 corals grew in height and width equally. The observation from the three research stations revealed the growth rate is better at station three than at other stations. Coral survival of *A. donei* ranged from 69-86%, *A. muricata* ranged from 71-77%, and *A. millepora* ranged from 75-83%. Environmental parameters that characterize station 1 are high nitrate and phosphate, and station 2 is temperature, power of hydrogen (pH), low salinity, and high total dissolved solid. Station 3 was characterized by low chlorophyll, conductivity, and dissolved oxygen parameters. The biplot graph revealed that it is suspected that turbidity and total suspended solid are parameters that characterize the three research stations. Based on the regression analysis results, it can be seen that the water turbidity parameter does not significantly affect coral growth with $p>0.05$.

Keywords: Gusung Tallang, restoration, spider web, transplantation

INTRODUCTION

Coral reef cover in the Spermonde Islands amounted to 1,556.97 ha (Ulumuddin et al. 2021), consisting of 64 coral genera from 16 families with a coral cover percentage of 27.83% and dominated by Acroporidae, Merulinidae, and Fungiidae corals (Sari et al. 2021). However, there have been indications of degradation due to increased macro alga cover due to high nutrients (Rani et al. 2014). Islands adjacent to the mainland tend to be stressed by human activities in the mainland and coastal areas. Pressures from land areas indirectly alter community structure and coral bleaching, especially of vulnerable *Acropora* corals (Lafratta et al. 2017). The same thing was found by Sully and van Woesik (2020): land use in coastal areas causes waters to become turbid. The influx of river flow carries most of the material, both sediment and nutrients that causes the seas to become increasingly turbid, thus disrupting the photosynthesis process of zooxanthellae (Storlazzi et al. 2015). Sully and van Woesik (2020) stated that as many as 12% of coral reefs in the world can be in moderate turbidity conditions, and 30% of coral reefs with moderate turbidity are in the world coral triangle. According to Zweifler et al. (2024), corals typically respond to increased turbidity by increasing their heterotrophic rates to compensate for low energy levels due to reduced sunlight penetration.

Sedimentation is a threat to corals as it blocks the penetration of sunlight for the photosynthesis process. While corals can recover from periodic natural disturbances, the regular occurrence of destructive human activities makes it increasingly difficult for them to recover (Parenden et al. 2021; Massiseng et al. 2022; Parenden et al. 2023). Wakwella et al. (2020) mentioned that high water turbidity impacts coral damage and low attachment of new corals. However, as Zweifler et al. (2021) have shown coral lenderproduction can reduce sedimentation effects. Ricardo et al. (2021) that 74% of coral settlements have decreased due to excessive sedimentation. In the face of these challenges, the importance of coral transplant activities cannot be overstated. By utilizing natural coral fragments, these activities can help us overcome ecosystem damage and repair the damage caused by human activities in coastal and marine areas.

The impact of turbidity that continues to occur results in damage and even death (Ismail et al. 2022). In addition, it can inhibit the metamorphosis of coral larvae in the water (Wakwella et al. 2020). The sunlight factor plays a role in coral growth, as can be seen from the increase in surface area and coral volume. The higher the sunlight, the more coral growth will occur, causing the surface area to become wider but the volume to decrease. Certain hard corals can adapt to high levels of sedimentation in aquatic environments, both physiologically and morphologically. These different physiological responses were attributed, in part, to coral morphology and highlighted key physiological processes that drive species distribution along high to low turbidity and depositional gradients.

On the other hand, morphological adaptation, which refers to the physical changes in the structure of the coral to cope with sedimentation, is the coral's ability to reject sediment passively. Various factors cause damage to coral reefs, so restoration efforts must be made by coral transplantation. However, media use can affect the abundance of fish species that are thought to damage coral transplants (Alhulu et al. 2023).

Coral reefs can live in turbid waters because they can clean themselves, depending on the area particle size and current strength. Various types of *Acropora* corals can live in turbid waters, such as thecoral *A. millepora* (Muzaki et al. 2020), *A. humilis* and *Montipora* sp., Poritidae, Faviidae, Mussidae (Siringoringo and Hadi 2014). With the above research, conducting transplantation activities in turbid waters using *Acropora* coral fragments is possible. Yang et al. (2024) found that Acropora coral species can grow between 4.31 and 6.24 cm/year, with the growth rate varying depending on factors such as water temperature and nutrient availability. Transplantation activities are needed to restore the sustainability of degraded coral reef resources. Many coral reef ecosystem restoration activities are carried out in clear waters because they are associated with sunlight. However, what if coral reef ecosystem damage occurs in turbid waters. This research aims to analyze the growth rate of Acropora coral, its survival in turbid waters, and its relationship with water turbidity parameters.

MATERIALS AND METHODS

Study area

This research was conducted from August 2021 to June 2022. Data was collected 7 times, monitoring for an intensive 10 months covering the rainy and dry seasons in transplant media placement site. The research location was placed in the inner zone area (inner zone / directly adjacent to the mainland of Makassar City, Indonesia), namely in the waters of Gusung Tallang, Makassar, South Sulawesi, Indonesia (Figure 1). There are 3 observation stations with a distance between stations of 50-60 meters, and at each station placed as many as five transplant media. The coral fragments used in this study were taken from coral colonies around the transplantation area in the turbid waters of Gusung Tallang. At station 1 is an area of entry and exit of ships and for station 2 is an area used as a tourist spot, while station 3 is an area where there are no human activities. However, these three locations still experience influences from the mainland of Makassar City such as river flow.

Experimental design

The selection of 3 coral species is based on the results of coral identification conducted in the initial survey using the Coral Finder guidebook (Kelley 2009) and the coral species identification book Coral of the World (Veron 2000). The corals used are *Acropora donei* Veron & Wallacea, 1984, *Acropora muricata* Linnaeus, 1758; and *Acropora millepora* (Erhenberg, 1834). The transplantation medium used an iron frame, and placement was reef star (spider) (Figure 2), which was adapted fromthe research of Williams et al. (2019) on Badi Island in the Spermonde Islands.

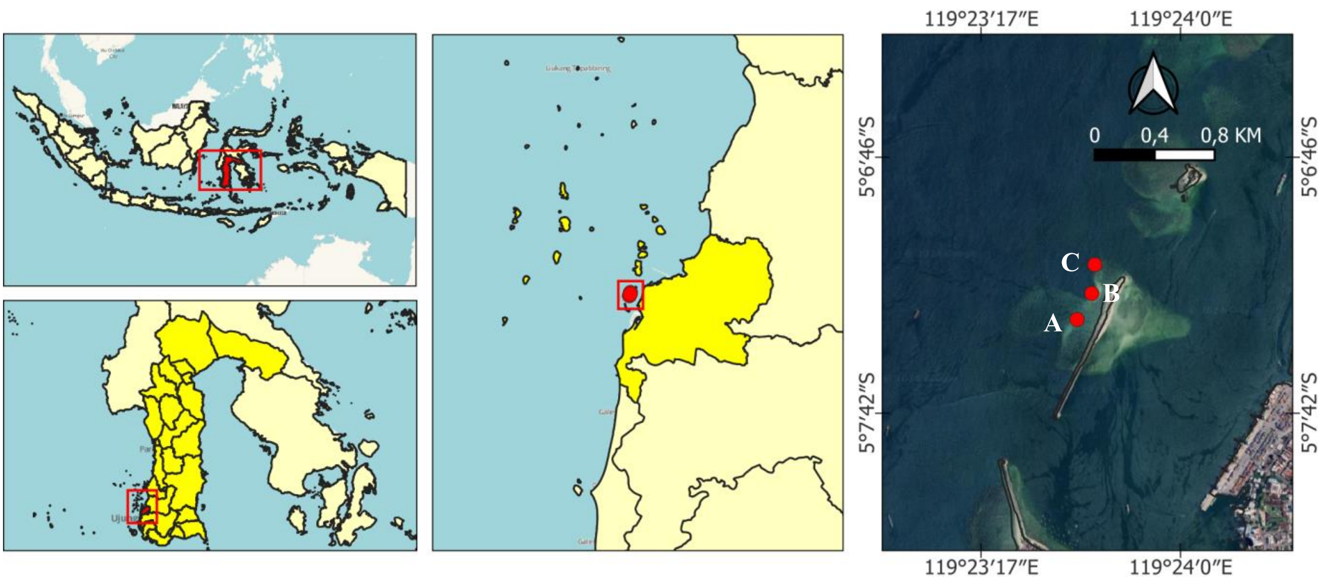

Figure 1. Research locations in Gusung Tallang, Spermonde Islands, Makassar, South Sulawesi, Indonesia: point 1 (5°7'9.372"S, 119°23'41.424"E), point 2 (5°7'21.252"S, 119°23'37.572"E), point 3 (5°7'15.6"S, 119°23'40.776"E)

Research by Parenden et al. (2023) found that *Acropora* corals were dominant and available to be used as coral fragments at the research site, so coral samples were taken in areas adjacent to the transplantation site. Each transplant medium was tied to 13 coral fragments, so each station was tied to as many as 65 coral fragments and tagged as a marker when monitoring the coral growth rate with a size of 5-7 cm. The size of the fragments taken was determined by research by Rani et al. (2017), which ranged in size from 5-12 centimeters.

Coral growth and water quality measurement

Measurement of coral growth using a push rod from the stem's lower end to the upper end (apical) on the main branch vertically using a caliper (Figure 3). Measure the coral branch width horizontally and count the number of colonies that survive and die from the beginning to the end of monitoring (observation). Measurements were made 7 times so that monitoring data T1-T7 were obtained. In addition, maintenance was carried out by cleaning the surface of coral polyps using a toothbrush and cleaning the algae cover.

Several environmental parameters, including salinity, temperature, pH, DO, chlorophyll, conductivity, TDS, and turbidity, were measured during periodic observations using a water quality checker. At the same time, water samples were taken and tested for TSS, nitrate, and phosphate at the Marine and Fisheries Science Laboratory, Universitas Hasanuddin, Makassar.

Data analysis

Measurement of growth rate and survival rate using the first equation:

$$P = \frac{L_t - L_0}{t}$$

Where: P: coral growth rate (mm day^{-1}); Lt: average (Length) at the end of the study (mm); $L_{0:}$ average (Length) at the beginning of the study (mm); T: observation time (days).

The survival rate uses the equation from (Effendie 1997):

$$S = \frac{N_t}{N_0} \text{ x } 100\%$$

Where: S: survival rate (%); Nt: number of coral fragments at the end of the study; N_0: number of coral fragments at the beginning of the study.

Growth rate data (length and width) of the 3 *Acropora* coral species were tested and then analyzed for differences with one-way analysis of variance (*one-way* ANOVA) at 5% alpha with the Student-Newman-Keuls test on SPSS. Survival data were descriptively analyzed for differences per observation period with the help of graphs. The relationship between parameters was analyzed using the Principal Component Analysis (PCA) technique, and the effect of turbidity parameters on growth rate was assessed using regression analysis.

RESULTS AND DISCUSSION

Water quality

Water turbidity and Total Suspended Solids (TSS), based on the Decree of the Minister of Environment No. 51 of 2004 and Government Regulation No. 82 of 2001, exceeded the predetermined standards, while other environmental parameters were still within the normal range (Table 1).

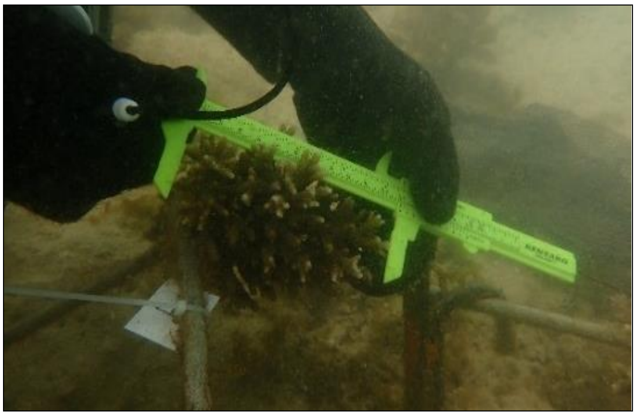

Figure 3. Measurement of coral growth using a caliper

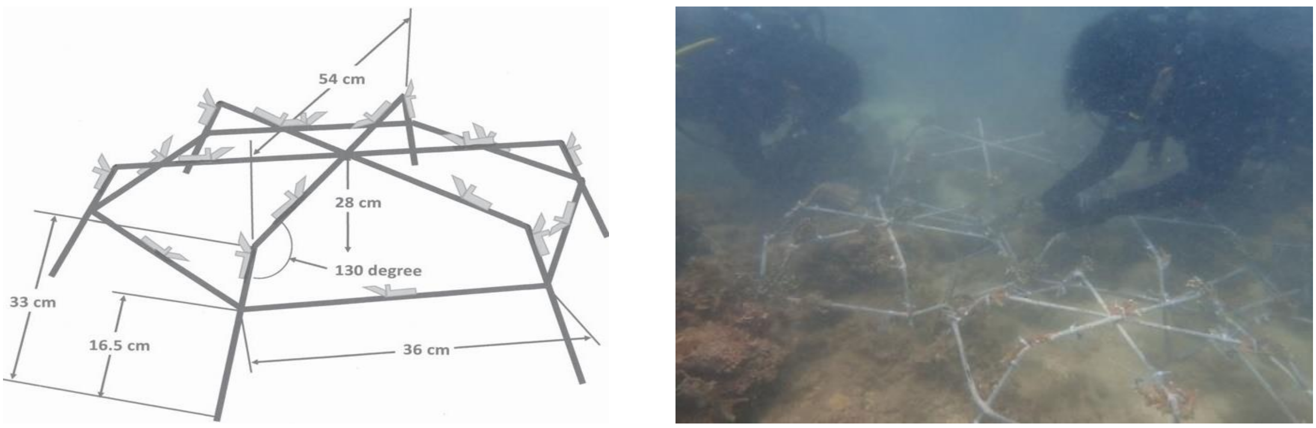

Figure 2. Photography illustration of iron frame model and placement

Table 1. Water quality parameters at the three research stations

Environmental parameters	Station 1		Station 2		Station 3		Quality standard	Description
	Range	**Mean±SE**	**Range**	**Mean±SE**	**Range**	**Mean±SE**		
pH	8.08-8.25	7.65±0.02	8.08-8.56	8.24±0.07	7.8-8.45	8.20±0.09	7-8.5	Meet
DO (mg/L)	5.57-7.42	7.46±0.29	5.67-7.71	6.77±0.31	6.31-7.89	6.87±0.24	>5	Meet
Conductivity (mhos/cm)	4.26-6.98	4.73±0.43	3.89-6.05	4.64±0.32	4.24-5.32	4.68±0.17	-	-
Turbidity (NTU)	12.5-12.8	12.4±1.91	9.3-12.3	11.4±1.56	8.7-11.3	10.3±1.57	<5	Does not meet
Temperature (°C)	28.9-30.1	31.50±0.17	29.2-31.8	30.48±0.40	28.4-29.5	29.01±0.19	28-30	Meet
Salinity (ppt)	28.2-30.7	29.87±0.33	26.9-30.9	29.3±0.61	27.9-31	29.56±0.49	33-34	Meet
TDS (mg/L)	45.6-50.4	48.47±0.76	42.5-50.6	47.78±1.25	45.5-50.4	48±0.84	1,000-2,000	Meet
Chlorophyll (CHLO)	31.4-41	36.40±1.49	40.5-46.8	43.23±0.83	30.7-49.2	36.43 ±2.59	-	-
TSS (mg/L)	131.8-193.3	159.53±8.18	120.9-190.3	159.9±10.31	143.5-170.9	157.1±3.83	20	Does not meet
Nitrate-NO3 (ppm)	0.0092-0.0395	0.0238±0.0044	0.001-0.0295	0.0231±0.0039	0.011-0.0241	0.0059±0.002	0.008	Not compliant
Phosphate-PO4 (ppm)	0.002-0.0201	0.0132±0.0027	0.002-0.0133	0.0077±0.002	0.0012-0.0142	0.0185±0.0021	0.015	Not compliant at Station 1

Note: Decree of the Minister of Environment No. 51 Year 2004 on Seawater Quality Standards; TDS using Government Regulation No. 82 Year 2001 on Water Quality Management and Pollution Control

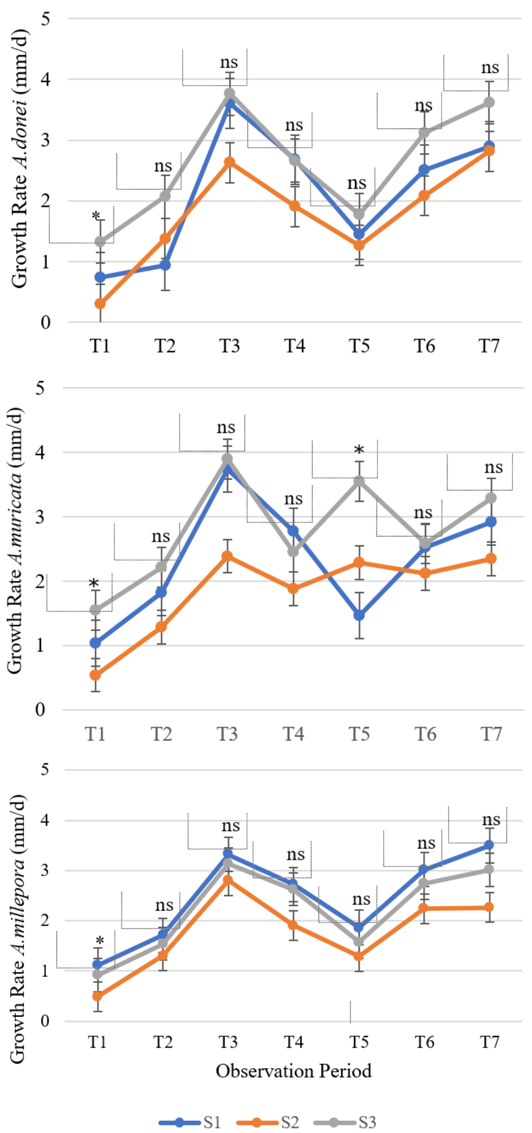

Figure 4. Colony height of *Acropora* sp. Corals (ns: not significantly different; *: significantly different; T: Time)

Growth rate (colony height)

The coral height growth rate is seen from how much change or increase in length from the size of the first fragment of planting until the end of observation. The coral growth rate of each type of *Acropora* sp. is presented in the figure below (Figure 4). T1 to T3 experienced an increase in high growth rate, decreased until T5, and increased again until the last observation. The coral growth rate of *A. muricata* at station 1 ranged from 1.03-3.74 mm/day, at station 2 ranged from 0.54-2.39 mm/day, while at station 3 ranged from 1.55-3.90 mm/day. The coral growth rate of *A. millepora* at station 1 ranged from 1.12-3.50 mm/day, station 2 ranged from 0.50-2.80 mm/day, and station 3 ranged from 0.92-3.13 mm/day. The growth rate of *A. donei* and *A. muricata* corals is higher at station 3 because this station is shallower (2.5 meters) so that the penetration of sunlight to the bottom so that zooxanthellae perform the process of photosynthesis well, another factor that supports that at this station there is a current movement that leads to deeper areas (outside) so that particles suspended in the water move quickly following the movement of the current.

Coral growth (colony width)

Figure 5 below shows the coral width growth rate of each test coral species at each observation station during the observation period.

Station 1 *Acropora's* growth rate was 0.90 mm/day, station 2 was 0.25 mm/day, and station 3 was 0.68 mm/day. *A. donei* corals at station 1 experienced a decrease in growth rate in the seventh observation of 2.42 mm/day, and in the sixth observation, the growth rate was 2.76 mm/day; a decrease in growth rate is thought to be due to suspended particles derived from high water turbidity covering coral polyps. The width growth rate in *A. muricata* corals at station 1 until the end of observation ranged from 0.65-3.79 mm/day, at station 2 ranged from 0.53-2.75 mm/day, while at station 3 it was 0.76-3.67 mm/day. The width growth rate of *A. millepora* coral in the first observation differed significantly. The first observation of *A. millepora* corals at station 1 amounted to 0.75 mm/day, station 2 to 0.22 mm/day, and station 3 to 1.10 mm/day.

Survival rate

Coral transplant survival in each coral species differs from one to another. Figure 6 shows that *A. donei* corals at the three stations have a survival rate ranging from 79-83%, *A. muricata* from 67-80%, and *A. millepora* from 71-86%. Figure 6 shows that corals *A. donei* and *A. muricata* at station 3 survivability are higher than in other stations, while coral *A. millepora* is higher in station 1.

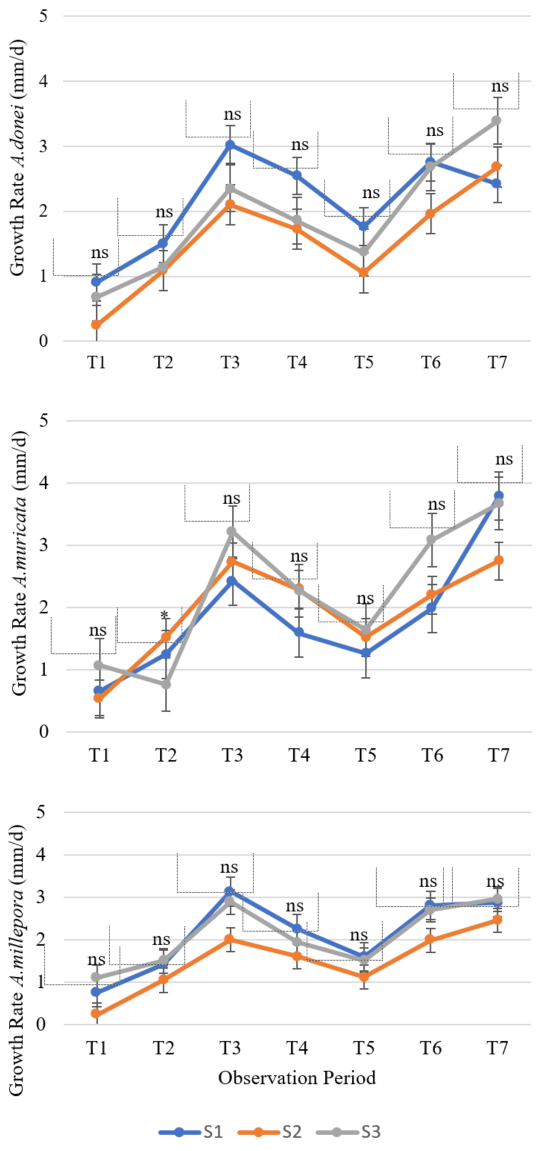

Figure 5. Colony width of *Acropora* sp. (ns: not significantly different; *: significantly different (p<0,05); T: Time)

Relationship between growth rate and environmental factors

This analysis is used to see the main components (environmental parameters) that have a strong influence on coral growth at each research station is determined from the angle (close to 0° or 180°), while uncorrelated forms an angle (close to 90°). The PCA (Principal Component Analysis) results can be seen in Figure 7. From the figure below, it can be seen that there are three groups, with group 1 at station 1 characterized by high nitrate and phosphate parameters and moderate coral growth rates. Higher TSS parameters characterize group 2 at station 2, while group 3 at station 3 is characterized by high DO and conductivity parameters and is associated with high growth rates of *A. donei* corals. TSS, turbidity, nitrate, and phosphate levels are closely related because they form an angle smaller than 90°.

TSS, turbidity, nitrate, and phosphate levels are closely related because they form an angle smaller than 90°. The water's turbidity level is usually associated with total solids in the water column, causing the water to become turbid, generally referred to as low brightness.

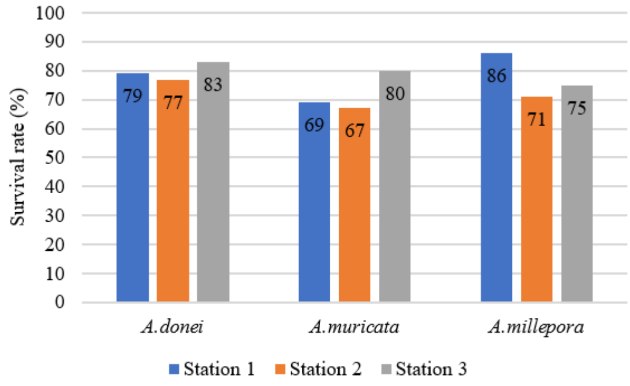

Figure 6. Survival rate coral genus *Acropora* sp.

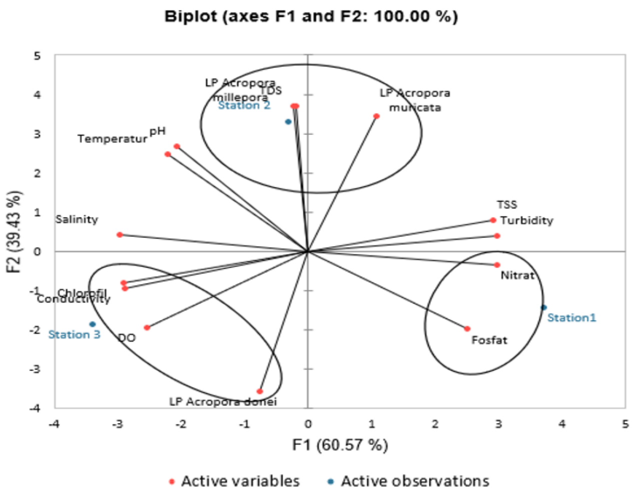

Figure 7. Biplot of characterizing factors of aquatic environmental parameters at each observation station

Effect of turbidity on growth rate

This study, conducted with thorough data collection, has revealed that water turbidity had no significant effect on the growth rate of the three coral species (Figure 8). Based on turbidity measurements at the three stations for seven monitoring times, the average turbidity range is 10-12 NTU. The turbidity parameter does not have a natural effect, allegedly due to the depth of the waters, which are still in the range of 2.5-5 meters, so there is still sunlight penetration. The linear regression graph for the type of coral *A. muricata* is decreasing because it has a value of -0,0197 the same thing happened to coral *A. millepora* with a value of -0,0012. For the results of ANOVA analysis, there is no relationship between the turbidityparameter and the growth rate of the test corals. The condition of the water environment, in general, supports the life of organisms.

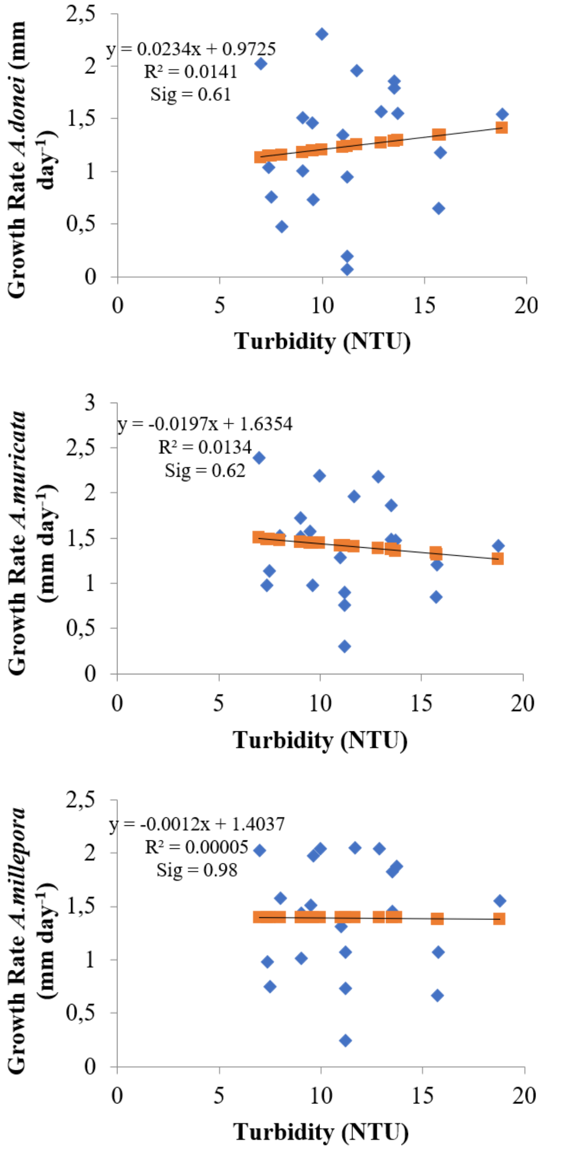

Figure 8. Linear regression analysis of the effect of turbidity on the growth rate of *Acropora* corals

Discussion

Temperatures are in the normal range, with Indonesian waters having a temperature range of 27.91-30.46°C (Kusuma et al. 2017) and Makassar Waters range from 25.7-30.89°C (Nababan et al. 2016). Coral reefs can tolerate temperatures up to 40 (Ellis et al. 2019), but sudden increases can cause coral mortality. Corals can live in salinities 30-35 ppt (Attamimi and Saraswati 2019; Chuang and Mitarai 2020), and the pH in Makassar Waters ranges from 7.9-8 (Valdany et al. 2022). The distance between the river mouth and the coral reef area influences the nitrate and phosphate content in the waters, and nitrate is an indicator of water quality (Valdany et al. 2022). The increase of nutrients in the water causes algae growth to increase, impacting competition for space and making it a competitor for space, thereby disrupting photosynthesis. This disruption can lead to a decrease in oxygen levels, affecting the survival of other marine organisms. Makassar Strait ranges from 30.65-34.63 psu (Prihatiningsih et al. 2021), and the pH in Makassar Waters ranges from 7.9-8 (Valdany et al. 2022). The distance between the river mouth and the coral reef area influences the nitrate and phosphate content in the waters, and nitrate is an indicator of water quality (Valdany et al. 2022). The increasing nutrients in the water cause higher algae growth, which has an impact on competition for space and become competitors for space and interferes with the photosynthesis process.

The Total Suspended Solid (TSS) content in the waters will affect the turbidity level in the seas. The TSS content in the waters exceeds the established quality standards. TSS is a solid that floats in the water column to interfere with the penetration of sunlight, which results in the photosynthesis process of zooxanthellae. Water turbidity ranges from 10.3-12.4 NTU, based on biota quality standards. The level of turbidity obtained exceeds the established criteria. These three stations have high turbidity levels because they are close to the mainland of Makassar City, where river flows can contribute particles to the waters. In addition, station 1 (one) is an area where ships enter and exit, so it can be assumed that sediment stirring occurs at the bottom of the water. The sedimentation process entering coastal and marine waters causes coral reefs to become damaged, and it is difficult to recruit new coral juveniles (Lafratta et al. 2017; Morgan et al. 2020; Muzaki et al. 2020).

Compared with the research results obtained, the growth rate of *A. muricata* height in this study is faster than in research conducted by Anderson et al. (2017). Corals *A. muricata* on the Great Barrier Reef (GBR) ranged from 2.49-4.78 cm/month. This study ranged from 0.54-3.90 mm/day at all observation stations (Howlett et al. 2021). Regularly cleaning coral fragments impacts growth because no organisms compete for sunlight or food. According to Faizal et al. (2023), the current speed in the area adjacent to the mainland at low tide ranges from 0.08-0.16 m/s, moving away from the mainland, while at high tide, it ranges from 0.8-0.12 m/s. The results of Wyrtki (1961) noted that in the June-October period in the Makassar Strait, there was a dominant current movement from the north to the south with a speed of 0.50 m/s in the inner part and the outer part with a speed of 0.12 m/set. Several factors, including abnormal instantaneous field conditions, morphological characteristics, and wind during data collection, may cause these differences. Meanwhile, the condition at station 1 is an entry and exit area for ships, so it is suspected that sediments at the bottom of the water can cover coral polyps.

Based on ANOVA analysis, there is a real difference in the first observation time between the three types of corals at the three stations. This is likely due to every kind of coral's adaptation and healing process. In addition, *A. muricata* coral has a real difference in the fifth observation at all three stations. Light intensity is thought to affect the difference. Light intensity is believed to affect different growth rates in the first and fifth observations in *A. muricata* corals. Research by Izumi et al. (2023) found that corals *A. tenuis, A. muricata*, and *A. intermedia* experienced faster growth at higher light intensities because there would be more algae symbionts on corals. They were added by Muzaki et al. (2019), who stated that there is no difference in length and width growth for *A. muricata* corals in Situbondo.

Water depth affects sunlight penetration. Research by Reskiwati et al. (2022) found that the distribution of corals at depth ranged from 3-9 meters. In addition, cleaning factors also affect growth rates; cleaning processes carried out regularly can increase survival rates and coral growth rates (Frias-Torres and van de Geer 2015). Cleaning of sedimentation particles on coral polyps and macroalgae attached to the transplant media greatly helps the growth of transplanted corals. Ritson-Williams et al. (2016) has been mentioned that macroalgae are known as growth inhibitors, resulting from their ability to cover coral habitats quickly during the growth process.

The area around the Great Barrier Reef of Australia shows that *A. muricata* corals have growth ranging from 2.49-4.78 cm/month in 3 (three) different areas (Howlett et al. 2021). They were added by Muzaki et al. (2019) that *A. muricata* corals can grow by 1 cm per month on concrete media. When compared to this study, the growth rate of *A. muricata* corals was more significant in this study. This is likely due to the cleaning done every time monitoring is done. Current velocities in areas adjacent to the mainland of Makassar City range from 0.14-0.16 m/s (Faizal et al. 2023). Sunlight affects photosynthesis (Kuanui et al. 2020), so low depths are more efficient for coral growth (Morgan et al. 2020).

Muzaki et al. (2020) found that the average growth rate of *A. millepora* corals per day ranged from 0.59-0.65 mm/day. Compared to this study, this study has a greater growth rate than previous studies. This is likely due to the influence of the length of the implementation of transplantation activities, which in this study was carried out for 385 days. In addition, theremoval of sediment is one of the determining factors and macroalgae that can inhibit coral growth (Ritson-Williams et al. 2016). Based on the results of ANOVA analysis, it can be seen that the growth rate of *A. muricata* coral width at station 3 (three) is lower than the other stations in the second observation. This is thought to be because, at the time of observation, there were fish that preyed on coral polyps so that corals. In addition, it is suspected that *A. muricata* corals tend to have faster height growth compared to width growth. Based on the results of ANOVA analysis, it can be seen that the growth rate of *A. muricata* coral width at station 3 (three) is lower than the other stations in the second observation. This is thought to be because, at the time of observation, there were fish that preyed on coral polyps so that corals. In addition, it is suspected that *A. muricata* corals tend to have more incredible height growth than width growth.

Survival of *A. muricata* corals at stations 1 and 2 was lower, while *A. millepora* corals were lower at stasion 3. This is because, in addition to having a higher level of turbidity and TSS, this area is also an area located right in front of a tourist spot that is often used for snorkeling and in the area placed rafts, so this is thought to affect the survival or survival of transplanted corals. According to Andika et al. (2020) *Acropora* sp. corals have a survival rate of 92% for 4 months. Research Kumar et al. (2017) in 2013 on the Gulf of Kachchh Marine National Park, India, obtained a survival rate of 93%. In this study, the survival or survival of *A. muricata* ranged from 67-75%. *A. millepora* corals have a 50-100% coral growth rate in clear and turbid waters (Muzaki et al. 2020). Other Acropora coral species found reasonable survival rates, such as *A. robusta* (Rani et al. 2017), corals *A. hyacinthus, A. intermedia, A. tenuis* and *A. humilis* (Howlett et al. 2021). The survival rate of transplanted corals depends on the process of taking fragments until the outplanting process, the absence of predators, and the cleaning of coral fragments. Other Acropora coral species found reasonable survival rates, such as *A. nobilis* 83,3% and *A. Cynthia* 100% (Kumar et al. 2017). The survival rate of transplanted corals depends on the process of taking fragments until the outplanting process, the absence of predators, and the cleaning of coral fragments.

The total suspended solid parameter contains various particles that enter the waters through rainwater into the seas (Jeong et al. 2020). River flow from the mainland of Makassar City contributes to particles and nutrients entering the waters. According to Storlazzi et al. (2015), sediment is the primary stressor for coral reefs and inhibits sunlight penetration. In addition, larger sediment particles will settle faster. Zweifler et al. (2021) state that the negative impact of water turbidity on coral physiology is smaller than the negative impact of sedimentation. Browne et al. (2015) added that coral mortality occurs when waters experience more than 150 mg/L turbidity. Coral reefs in turbid waters can thrive under high sediment loads due to acclimatization and adaptation mechanisms. The ability of various coral species to adapt to environmental factors, especially turbidity makes these corals able to live in turbid waters. Lender-producing corals can mitigate sedimentation effects (Zweifler et al. 2021). Based on observations in the field, it can be seen that in the rainy season, the turbidity of the waters is very high, and in the summer, the turbidity level becomes low. Coral *Acropora* is suspected of having good growth due to adaptation patterns in unfavorable water conditions.

In conclusion, the results of this study indicate that in the rainy season, water turbidity is very high, and in the summer, the level of turbidity becomes low. Coral *Acropora* is thought to have good growth due to adaptation patterns to unfavorable water conditions. Based on the results of data analysis and discussion, there are significant differences in growth rates in the first observation for coral height and the fifth observation for *A. muricata* corals. For the width growth rate, there was a considerable difference in *A. muricata* coral in the second observation. The survival rate of the three types of corals transplanted at the three stations was above 50%, with a range of 69-86% for *A. donei*, 71-77% for *A. muricata*, and 75-83% for *A. millepora* coral transplantation conducted in the turbid waters of Gusung Tallang can be said to be successful.

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